

What is claimed is:

- 1 1. The method of receiving data values transmitted as a tone-modulated
2 signal from a r m te m dem via a voice-grade telephone link to a local general
3 purpose computer, said local computer having an internal processor and a
4 memory, said method comprising, in combination, the steps of:
5 connecting an analog-to-digital converter between said telephone link
6 and said computer,
7 operating said analog-to-digital converter to store in said memory a
8 incoming sequence of digital values representing samples of the amplitude of
9 said tone-modulated signal as received over said telephone link, and
10 operating said processor to execute a demodulation program stored in
11 said memory for processing said sequence of values to reconstruct said data
12 values.
- 1 2. The method of claim 1 further comprising, in combination, the steps f:
2 connecting a digital-to-analog converter between said telephone link and
3 said computer,
4 operating said processor to execute a modulation program stored in said
5 memory for processing outgoing data values into an outgoing sequence of
6 amplitude values, and
7 operating said digital-to-analog converter to transmit a tone-modulated
8 signal to said remote modem.
- 1 3. The method of claim 1 further comprising, in combination, the steps of:
2 monitoring the operation of said analog-to-digital converter to detect
3 the reception of a predetermined number of said incoming digital values, and
4 issuing an interrupt to said processor when said number is detected t
5 begin the execution of said demodulation program.
- 7 4. The method of claim 2 further comprising, in combination, the steps f:

8 monitoring the operation of said analog-to-digital converter to detect
9 the reception of a predetermined number f said incoming digital values, and
10 issuing an interrupt to said processor when said number is detected to
11 begin the execution of said modulation and demodulation programs.

1 5. The method of claim 1 wherein said local computer includes a direct
2 memory access controller for handling data transfers to and from said memory
3 independently of the operation of said processor, said method further
4 comprising, in combination, the steps of:

5 delivering a direct memory access transfer request signal from said
6 analog-to-digital converter to said direct memory access controller each tim
7 said converter produces a given one of said values in said incoming sequence
8 to effect the storage of said given value in said memory.

1 6. In combination with a computer of the class comprising an
2 integrated-circuit microprocessor and a random access memory, apparatus for
3 transmitting and receiving digital data over an analog communications link
4 comprising, in combination,

5 an input register, an output register, and means for transferring units
6 of information between each of said registers and said random-access memory,

7 analog-to-digital conversion means having an input connected to receive
8 an incoming analog signal from said link and an output connected to supply a
9 sequence of incoming digital sample values to said input register, each of
10 said incoming digital sample values representing the amplitude of a sample of
11 said incoming analog signal,

12 digital-to-analog conversion means having an input connected to receive
13 outgoing digital sample values from said output register, each of said
14 outgoing digital sample values being indicative of the amplitude of a sample
15 of an analog output signal, said digital-to-analog conversion means having an
16 output connected to supply said output signal to said link,

17 a mod m modulation routine stored in said random-access memory and
18 executed by said microprocessor for translating digital data to be transmitted
19 into said outgoing sample values, and
20 a modem demodulation routine stored in said random-access memory and
21 executed by said microprocessor for translating said incoming sample values
22 into digital data.

1 7. Apparatus as set forth in claim 6 including means coupled to said
2 analog-to-digital conversion means for generating an interrupt signal each
3 time a predetermined number of incoming digital samples have been received,
4 and means for delivering said interrupt signal to said microprocessor to
5 initiate execution of said modem demodulation routine.

1 8. Apparatus as set forth in claim 7 further including means responsive to
2 the receipt of said interrupt signal by said microprocessor for additionally
3 initiating the execution of said modem modulation routine.

1 9. Apparatus as set forth in claim 7 further including, in combination,
2 a direct memory access controller connected to said random access memory
3 for transferring data to and from said memory without the aid of said
4 microprocessor,
5 means responsive to said analog-to-digital conversion means for
6 transmitting a memory storage request signal to said controller to transfer
7 of said incoming digital samples to said random access memory, and
8 means responsive to the execution of said modulation routine for
9 transmitting a memory retrieval request signal to said controller to transfer
10 said outgoing digital values to said digital-to-analog conversion means.

10. In combination with a computer of the class comprising an integrated-
circuit microprocessor and a random access memory, apparatus for transmitting
and receiving information over an analog communications link comprising, in combination

a sample data input register,
a sample data output register,

analog-to-digital conversion means having an input connected to receive an incoming analog signal from said link and an output connected to supply a sequence of incoming digital sample values to said sample data input register, each of said incoming digital sample values representing the amplitude of a sample of said incoming analog signal,

digital-to-analog conversion means having an input connected to receive outgoing digital sample values from said sample data output register, each of said outgoing digital sample values being indicative of the amplitude of a sample of an analog output signal, said digital-to-analog conversion means having an output connected to supply said analog output signal to said link,

an incoming sample processing routine stored in said random access memory,

an outgoing sample processing routine stored in said random access memory,

means coupled to said analog-to-digital conversion means for generating an interrupt signal each time a predetermined number of incoming digital samples have been received, and means for delivering said interrupt signal to said microprocessor to initiate execution of said incoming sample processing routine.

11. Apparatus as set forth in claim 10 further including means responsive to the receipt of said interrupt signal by said microprocessor for additionally initiating the execution of said outgoing sample processing routine.

12. Apparatus as set forth in claim 11 further including, in combination, a direct memory access controller connected to said random access memory for transferring data to and from said memory without the aid of said microprocessor,

5 means responsive to said analog-to-digital conversion means for
6 transmitting a memory storage request signal to said controller to transfer of
7 said incoming digital samples to said random access memory, and

8 means responsive to the execution of said outgoing sample processing
9 routine for transmitting a memory retrieval request signal to said controller
10 to transfer said outgoing digital values to said digital-to-analog conversion
11 means.

1 13. Apparatus as set forth in claim 10 wherein said information being
2 received over said telephone link takes the form of a tone-modulated signal
3 produced by a remotely located modem to represent a digital message signal and
4 wherein the execution of said incoming sample processing routine demodulates
5 said sample values to reconstruct said message data.

1 14. Apparatus as set forth in claim 10 wherein said computer further
2 comprises a magnetic disk storage device, wherein said information being
3 received over said telephone link takes the form of an analog voice signal,
4 and wherein the execution of said incoming sample processing routine stores a
5 file of digital values representative of said analog voice signal on said
6 magnetic disk storage device.

1 15. Apparatus as set forth in claim 14 wherein the execution of said
2 outgoing sample processing routine retrieves a file of outgoing digital sample
3 values from said magnetic disk storage device and transfers said outgoing
4 values to said digital-to-analog conversion means to transmit a voice signal
5 over said telephone link.

1 16. Apparatus as set forth in claim 15 further comprises, in combination,
2 means for detecting ringing signal received over said telephone link
3 from a remote caller,

4 a call answering routine stored in said memory and executed by said
5 computer for executing said outgoing sample processing routine to transmit a
6 voice acknowledgment to said remote caller and for thereafter executing said
7 incoming sample processing routine for recording an incoming voice message
8 from said remote caller.

1 17. In combination with a computer of the class comprising, in combinati n,
2 a microprocessor,
3 a random access memory,
4 a system bus composed of data and control conductors
5 interconnecting said microprocessor and said memory,
6 a direct memory access controller connected to said bus for
7 supervising data transfers to and from said memory via the said system
8 bus independently of the operation of said microprocessor, and
9 at least one expansion slot socket connected to said system bus,
10 An auxiliary circuit card for communicating between said computer and a
11 remote device via a voice-band telephone circuit, said circuit card
12 comprising, in combination,
13 an edge connector including a plurality of electrical terminals
14 adapted for insertion into said expansion slot socket to establish
15 electrical connections to said system bus,
16 a hybrid circuit having a bi-directional telephone line port, an
17 incoming port for delivering an incoming voice-band analog signal, and
18 an outgoing voice-band port for receiving an outgoing voice-band analog
19 signal,
20 a telephone line adapter circuit connected between said teleph ne
21 circuit and said bi-directional line port of said hybrid circuit, said
22 line adapter circuit including a hook switch for selectively connecting
23 and disconnecting said telephone circuit and said line port in response
24 to a first control signal, a loop-current detector for generating a
25 second contr l signal indicating when an active connection has been

26 .. established with said remote device, a ringing-signal detector for
27 generating a third control signal indicating when ringing signals are
28 being received over said telephone circuit, and circuit means for
29 transmitting said control signals between said auxiliary circuit card
30 and said system bus via said edge connector,

31 an incoming sample data register connected to said edge connector,
32 an analog-to-digital converter connected between the incoming p rt
33 of said hybrid circuit and said incoming sample data register for
34 converting sample amplitudes of said incoming voice-band analog signal
35 into incoming digital sample values which are temporarily stored in said
36 incoming sample data register,

37 first control means for applying a direct memory access storage
38 request signal to said edge connector for transmission via said bus t
39 said direct memory access controller each time an incoming digital
40 sample value is temporarily stored in said incoming data register to
41 effect the transfer of said incoming sample value to said memory,

42 an outgoing sample data register connected to said edge connector,
43 a digital-to-analog converter connected between the outgoing port
44 of said hybrid circuit and said outgoing sample data register for
45 converting digital sample amplitude values in said output register into
46 said outgoing voice-band analog signal,

47 second control means for applying a direct memory access read
48 request signal to said edge connector for transmission via said bus to
49 said direct memory access controller each time an sample value in said
50 output register has been converted by said digital-to-analog converter,
51 and

52 third control means applying an interrupt signal to said edge
53 connector for transmission via said bus to said microprocessor each time
54 a predetermined number of incoming digital values have been processed by
55 said analog-to-digital converter.

1 18. In combination with a computer of the class comprising, in combination,
2 a microprocessor, a random access memory, and a system bus interconnecting
3 said microprocessor and said memory, an arrangement for communicating between
4 said computer and a remote device via a voice-band telephone circuit
5 connection to a telephone switching office, said arrangement comprising, in
6 combination,

7 a telephone line adapter circuit connected between said telephone
8 circuit and said bi-directional line port of said hybrid circuit, said line
9 adapter circuit including a hook switch for selectively connecting and
10 disconnecting said telephone circuit and said line port in response to a first
11 control signal, a loop-current detector for generating a second control signal
12 indicating when an active connection has been established with said switching
13 office, a ringing-signal detector for generating a third control signal
14 indicating when ringing signals are being received over said telephone circuit
15 from said switching office, and circuit means for transmitting said control
16 signals between said auxiliary circuit card and said system bus, and

17 signal conversion means connected between said telephone circuit and
18 said edge connector for translating an incoming analog signal into incoming
19 digitally-expressed values representative of the amplitude of samples of said
20 incoming analog signal, for supplying said values to said bus via said edge
21 connector, and for translating outgoing digital sample values received from
22 said bus via said edge connector into a voice band analog signal transmitted
23 over said telephone circuit, and

24 call progress control means for supervising the connection between said
25 computer and said telephone circuit via said auxiliary circuit card, said call
26 progress control means comprising, in combination,

27 means including a first set of instructions stored in said memory
28 and executed by said microprocessor for applying a sequence of outgoing
29 digital sample values to said bus which are representative of a sequenc
30 of dual dial-tone signals suitable for establishing a dial-up connecti n
31 via said switching office to said rem te device, and

32 means including a second set of instructions stored in said memory
33 and executed by said microprocessor for processing said incoming
34 digitally-expressed sample values to detect the presence of an answer
35 tone received over said telephone circuit from said switching office.

1 19. The method set forth in claim 1 further comprising, in combination, the
2 step of receiving and recording voice messages at times when said data values
3 are not being transmitted comprising, in combination, the step of operating
4 said processor to record on a storage device a file of digital signals derived
5 from said incoming sequence, and thereafter playing back said voice messages
6 by reading said file from said storage device.

1 20. The method set forth in claim 1 wherein said step of operating said
2 processor alternatively consists of demodulating binarily expressed computer
3 data or translating graphical data being received from a facsimile
4 transmission device.

1 21. The method set forth in claim 20 wherein said step of operating said
2 processor comprises the further alternative step of digitally recording voice
3 messages by storing the output from said analog-to-digital converter in a non-
4 volatile storage device for later playback.

1 22. The method set forth in claim 1 wherein said step of operating said
2 processor to execute a demodulation program comprises, in combination,
3 comparing the sampling rate at which said analog-to-digital converter operates
4 with the sampling rate employed by said remote modem and varying the number of
5 samples generated during demodulation of said sequence of values so that said
6 reconstructed data values to provide the same data rate as that of the
7 transmitted data values produced by said remote modem.